Vineyard Management Practices and the Quality of Grapes and Grape Products in the Pacific Northwest

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PROJECT OBJECTIVES:

1. Integrate the development and use of analytical methods for the evaluation of phenolic compounds and other chemical indicators of quality in fruit, fruit products, and wine.
2. Determine effects of water management on wine grape productivity and fruit maturity.
3. Determine effects of vineyard and vine microclimate on fruit development, vine productivity, and fruit quality, particularly phenolic compounds.

MAJOR ACCOMPLISHMENTS (2007–2010):

Understanding limitations of and comparisons between alternate analytical methods:
Different analytical and sample preparation methods provide different results. Sample preparation is an often overlooked step that is vital to the outcome of compound analyses. Method conditions require exactness to permit researchers and industry laboratories to compare and discuss results. We contrasted data and defined the relationship between grape samples prepared by a method common in industry (juicing) to chemically extracted samples (typical of a research setting). Free amino acids and ammonia, calculated as YAN (yeast assimilable nitrogen), were evaluated in juices and extracts from an established vine nutrient study. YAN values are crucial for wineries to ensure healthy alcoholic and malolactic fermentations.

Kaolin particle film and water deficit have interactive influences on vine water use efficiency and grape quality:
Wine grapes in arid climates often are irrigated with a deficit amount of water to improve fruit quality for wine production and to conserve water. Water deficiency reduces the size of the vine canopy and increases the risk of fruit exposure to potentially damaging solar radiation. We determined that foliar application of a kaolin-based reflectant reduced leaf surface and canopy temperature, and increased vine water use efficiency (as has been claimed by manufacturers) only under non-limiting soil moisture; the particle film did not eliminate heat stress symptoms on fruit. Merlot, Cabernet Sauvignon, and Viognier grapevines that were most water-

stressed were least responsive to the foliar reflectant. However, the reflectant increased the strength of correlations between fruit maturity and yield attributes, suggesting that it may increase berry quality uniformity within a vintage. Results from this study provide information to aid growers in arid regions with high solar radiation in determining the economic benefit of reflectant application for meeting their production and quality goals.

Water deficits affect seed and berry weights in grapes, volatile composition in Merlot wine:

The size and tissue composition of red-skinned wine grape berries are of economic interest because of the distribution of compounds associated with wine sensory attributes. Soil water deficits increased by up to 27 percent the proportion of seed to total berry fresh weight, but had no effect on berry size uniformity. Results reveal a crucial relationship between water conservation and potential wine style because a greater ratio of seed to total berry fresh weight alters the proportion of seed relative to skin-derived compounds available for extraction during fermentation.

The relationship between vine water status, grape composition, and wine quality has been investigated over the past 30 years and is still of interest today because of the complexity of factors that impact grape and wine quality. The objective of this research was to investigate the influence of vine water status during berry development on the aroma profile of the resulting wine. We identified that grapevine water status during berry development alters the amount of some compounds in the volatile aroma profile of the resulting wine. Grapes from water-stressed vines produced wine with increased amounts of vitispiranes, β-damascenone, guaiacol, 4-methylguaiacol, 4-ethylguaiacol, and 4-vinylguaiacol relative to grapes from well-watered vines. Results contribute to the growing body of knowledge of the complex influence of abiotic factors on berry physiology and the composition of the resulting wine.

Phenolic management:

Winemaking conditions influence the final structure of a wine. Proanthocyanidins (a class of phenolics found in grape skins and seeds) are important indicators of red wine quality. In cooperation with a commercial winery that had novel shaped fermentation vessels allowing seed removal at certain time, the effect of early removal of seeds during 'Merlot' fermentation (seed-removed wine) was examined and compared to traditionally made wine (control wine). Winemakers assumed that reducing the duration a fermenting red wine was in contact with its seeds would reduce the perceived astringency of that wine. The results were unexpected, though only small differences in proanthocyanidin composition were actually measured, wines with traditional seed contact time were judged better, and the winemakers continue with their traditional method. This study contributed to our understanding of winemaking strategies.

Using a model red grape variety ('Merlot'), we demonstrated the deleterious effects of short exposure to extreme high fruit temperatures on classes of compounds associated with grape and wine quality: anthocyanins, proanthocyanidins, and flavonols. Knowledge of natural temperature fluctuations in vineyards and their effects on grape

quality led to practical recommendations for growers to adjust vineyard management practices in warm grape growing regions to maintain an environment conducive to the highest quality fruit.

Dynamic crop monitoring and yield estimation:
This work addressed the grape industry's call for an automated alternative to the labor intensive practice of estimating yield from grape samples collected by hand. The Trellis Tension Monitor (TTM) was developed over several years in this project. The TTM can be used for tracking crop growth, berry development, and estimating yield in trellised vines. We showed that the TTM approach outperformed the commercial yield estimation technique used by major juice processors.

TECHNOLOGY TRANSFER/OUTREACH (2007–2010):
- Invited to present research findings at State and regional grape and wine industry meetings, workshops, field days (Colorado, Idaho, Oregon, and Wwashington); and at national scientific meetings (ASHS, PGRSA).
- Presented guest lectures and seminars (University of Idaho, Boise State University, and Treasure Valley Community College).
- Presented research findings at national and international scientific meetings: American Chemical Society (ACS), International Cool Climate Symposium (ICCS), International Conference on Polyphenols, American Society for Enology and Viticulture (ASEV), International Berry Health Benefits Symposium, Institute for Food Technologists (IFT).
- Provided facility tours and project information to Northwest wine industry representatives; local university and college students; visiting scientists; government representatives (local, State, and Federal), Cub Scout troops, etc.

EXTERNAL SUPPORT (2007–2010):
- 2006-2010: Northwest Center for Small Fruits Research (three projects)
- 2007-2010: Viticulture Consortium West (three projects)
- 2009-2010: Idaho State Department of Agriculture
- 2009: California Department of Food and Agriculture

COLLABORATORS:
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RECENT PUBLICATIONS (2007–2010):

- Glenn, D.M., Cooley, N., Walker, R., Clingeleffer, P., and Shellie, K.C. 2010. Impact of kaolin particle film and water deficit on wine grape water use efficiency and plant water relations. *HortSci.* 45:1178-1187.
- Keller, M., Tarara, J.M., and Mills, L.J. 2010. Spring temperatures alter reproductive development in grapevines. *Austr. J. Grape Wine Res.* (in press).
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- Lee, J., Keller, K.E., Rennaker, C., and Martin, R.R. 2009. Influence of *grapevine leafroll associated viruses* (GLRaV-2 and -3) on the fruit composition of Oregon *Vitis vinifera* L. cv. Pinot noir: free amino acids, sugars, and organic acids. *Food Chem.* 117:99-105.
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- Cohen, S.D., Tarara, J.M., and Kennedy, J.A. 2008. Assessing the impact of temperature on grape phenolic metabolism. *Anal. Chim. Acta.* 621:57-67.

- Dossett, M., Lee, J., and Finn, C.E. 2008 Inheritance of phenological, vegetative, and fruit chemistry traits in black raspberry. *J. Am. Soc. Hort. Sci.* 133:408-417.

- Lee, J., Kennedy, J.A., Devlin, C., Redhead, M., and Rennaker, C. 2008. Effect of early seed removal during fermentation on proanthocyanidin extraction in red wine: a commercial production example. *Food Chem.* 107:1270-1273.
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- Shellie, K.C. 2007. Viticultural performance of red and white wine grape cultivars in southwestern Idaho. *HortTech.* 17:595-603.
- Tarara, J.M. and Hoheisel, G.-A. 2007. Low-cost shielding to minimize radiation errors of temperature sensors in the field. *HortSci.* 42:1372-1379.